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AQUACULTURE EXTENSION SERVICES REVIEW : NEPAL

K.G. Rajbanshi
CHA/2/835, Nursery Lane
Banslari, Mahajgunj
Kathmandu, Nepal

FOOD AND AGRICULTURE ORGANIZATION OF UNITED NATIONS
ROME, 1995

PREPARATION OF THIS DOCUMENT

In 1982, FAO Fisheries Circular N. 747 entitled "Aquaculture extension services review" was published. This publication gave a brief outline of the status of aquaculture extension services in 32 countries. In those early days of aquaculture development, aquaculture extension services were in their infancy, and in many countries they were not in existence.

The last decade, however, has seen dramatic development of aquaculture, especially in Asia. It is believed that the extension services played an important role in this rapid development by effectively transferring culture technologies to the producers. It is therefore important that the present status of the aquaculture extension services are reviewed, especially in the countries where aquaculture development is believed to have made some impacts in the socio-economic life of the rural people.

Bearing this in mind, this review has been prepared within the framework of the Normative Programme activities of the FAO Inland Water Resources and Aquaculture Service of the Fishery Resources Division. The original text, prepared by Mr. K.G. Rajbanshi, in Kathmandu, has been edited by Mr. P.C. Choudhury in Rome.

The author gratefully acknowledges the assistance of various institutions under the Ministry of Agriculture for providing data/information related to the subject matter.

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ABSTRACT

Nepal is a landlocked country of about 20 million people. Agriculture is the mainstay of the economy of the country; and it provides employment for 90 percent of the population and produces 60 percent of the GDP.

The contribution of the fisheries sub-sector to the GDP is very small and the per capita fish availability is less than 1 kg. Of the total fish production of about 17,000 mt, aquaculture contributes about 10,000 mt; and the rest comes from the capture fisheries in the rivers and lakes. With the increasing demand for fish for local consumption as well as for export to the lucrative markets in India, His Majesty's Government has given priority in the Eighth Five Year Plan for the development of fish culture in ponds, lakes and paddy fields.

Under the Department of Agriculture Development, the Fisheries Development Division is responsible for the overall development of fisheries in the country. However, in general, the fisheries (including aquaculture) extension services are provided by the agriculture extension services through the Regional and District Agriculture Development Offices. At the village level, the Progressive Farmers play a very important role in transferring culture technologies to the neighbouring farmers through demonstration and training.

So far, most of the aquaculture extension services have been provided through the implementation of two aquaculture development projects funded by the Asian Development Bank. The US Peace Corps Volunteers and the Japanese Overseas Cooperation Volunteers have also assisted in the operation of the aquaculture extension services.

LIST OF ABBREVIATIONS

ADB -	Asian Development Bank
ADB/N -	Agriculture Development Bank/ Nepal
ADO -	Agriculture Development Officer
ADP -	Aquaculture Development Project
AIC -	Agriculture Inputs Corporation
DADO -	District Agriculture Development Office
DFAMS -	Department of Food and Agriculture Marketing Services
DOAD -	Department of Agriculture Development
DOIHM -	Department of Irrigation, Hydrology and meteorology
FAO -	Food and Agriculture Organization
FDC -	Fisheries Development Centre
FDD -	Fisheries Development Division
FFHC -	Freedom From Hunger Campaign
GDP -	Gross Domestic Product
HMG -	His Majesty's Government
IFAD -	International Fund for Agriculture Development
JOCV -	Japanese Overseas Cooperation Volunteer
JT -	Junior Technician
JTA -	Junior Technical Assistant
MOA -	Ministry of Agriculture
NARC -	National Agricultural Research Unit
NASRI -	National Animal Science Research Institute
NGO -	Non-Governmental Organization
NPC -	National Planning Commission
NRs -	Nepalese Rupees
PCV -	Peace Corps Volunteer
UNDP -	United Nations Development Programme
USAID -	United States Agency for International Development
WFP -	World Food Programme

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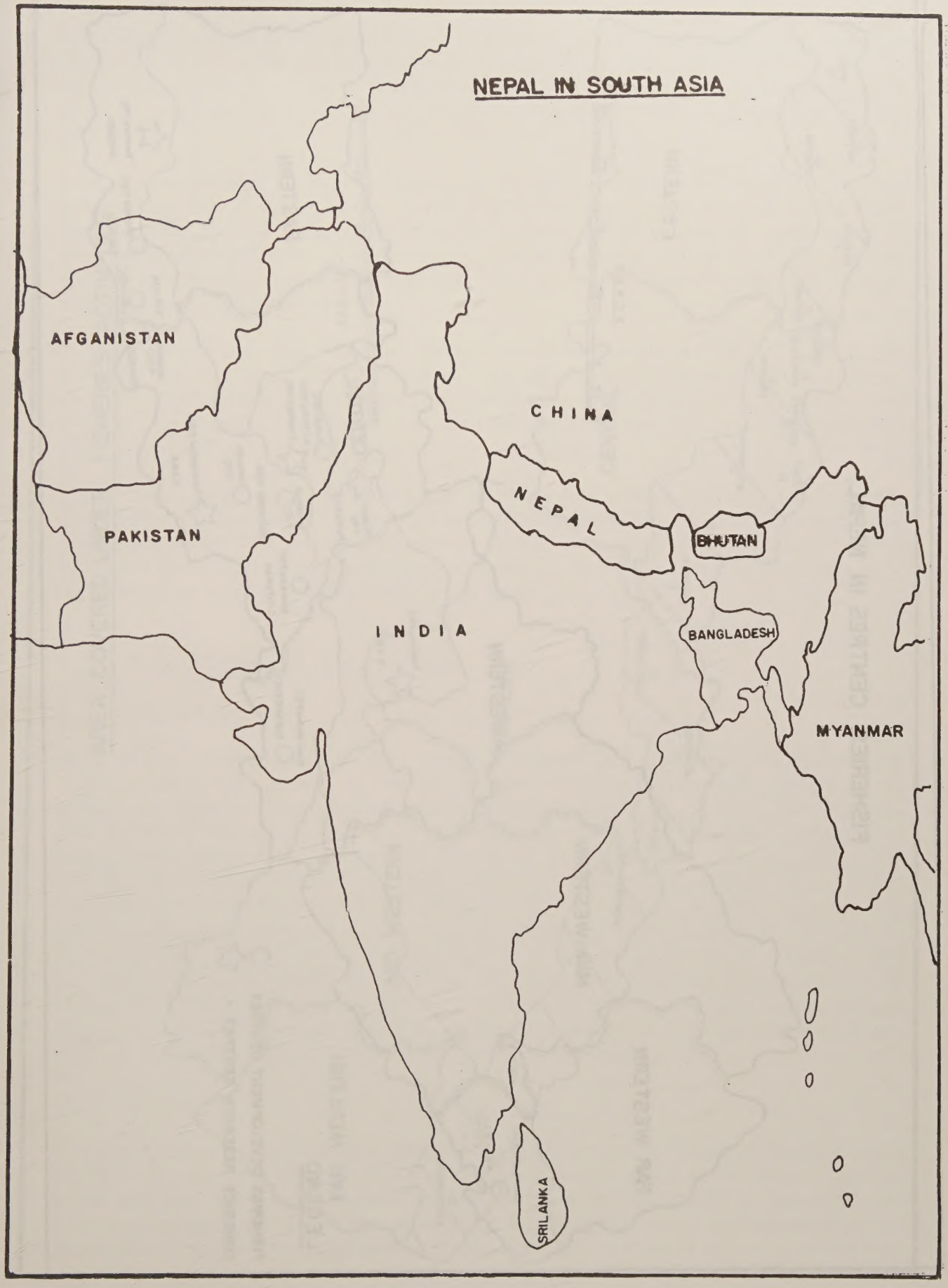
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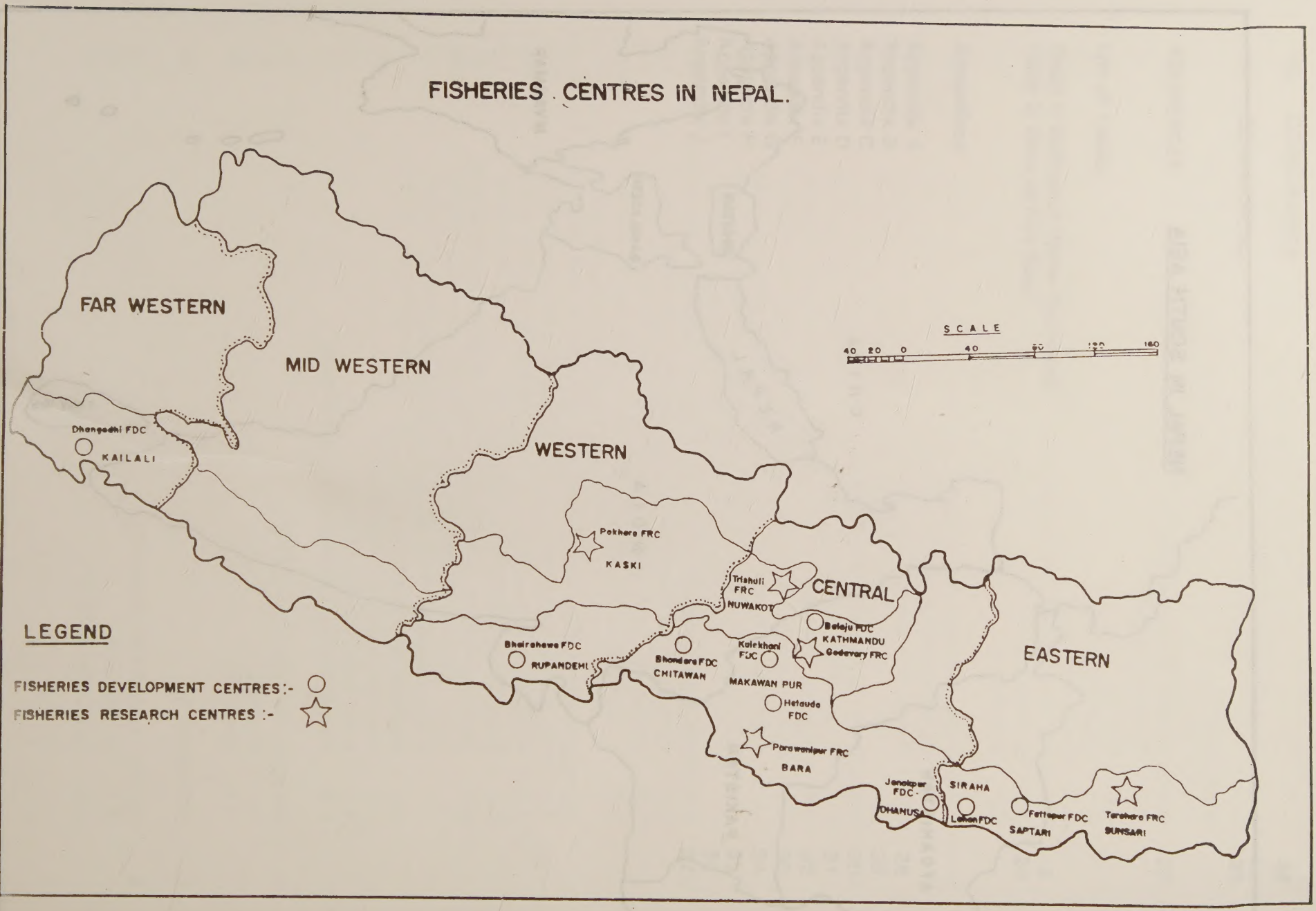
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MAKAWAN PUR
Hetauda FDC
Parawanipur FRC
BARA
Janakpur FDC
DHANUSA
SIRAHA
Lahan FDC
Fattepur FDC
SAPTARI
Tarahara FRC
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LEGEND
FISHERIES DEVELOPMENT CENTRES:-
FISHERIES RESEARCH CENTRES :-

AREA COVERED UNDER FISHERIES ACTIVITIES

1. INTRODUCTION

The dominant sector of economy of a mountainous country Nepal is agriculture, in which more than 90 per cent of the population are engaged in producing about 60 percent of the Gross Domestic Product (GDP). The agriculture production has not been able to keep pace with the population growth with the result that per capita food availability has steadily declining.

A rapid and sustained increase in agricultural production is necessary to meet a growing demand for food in the country, to raise income as well as to provide employment opportunities for the large portion of the population dependent on agriculture. A sustainable development of agriculture is needed to provide onward linkages to industries and to increase exports to earn foreign exchange required for financing the importation of inputs needed for higher growth.

In this national task, the Fisheries Development Programme, an integral part of the agriculture sector could play a significant role by creating employment opportunities, generating additional income and supplying protein rich fish to fight malnutrition in the rural areas of the country. With these objectives the Fisheries Development Programme has been given high priority in the last two Five Year Plans.

In this paper an attempt has been made to review the ongoing Fisheries Development Programme with speciai reference to the aquaculture extension in the field and efforts have been made to identifying the achievements as well as constraints which have inhabited growth in the past, and to recommend strategies by which a sustained system could be established for possible rapid growth in the future.

2. BACKGROUND OF THE COUNTRY

2.1 Physical Features

Nepal is a small landlocked country wedged between India and Tibet, an autonomous region of China, with an area of 147,181 Square Kilometres. Ecologically, the country is divided into three parallel geographic zones running east to west-the Terai plain, the Hills (the foothills of the Himalaya) and the Himalayan mountains. The terai plain extends from east to west along the southern side of the country as an extension of the Gangetic plains of India. It includes most of the fertile land and tropical/sub-tropical forest. Water resources and fertile land permit the cultivation of a wide variety of crops, livestock and fish. The hilly area is located in the middle part of the country varying in altitude of 610 meters to 4877 meters above the sea level. It comprises a number of productive and attractive valleys and basins. In the north, the Himalayan Mountains ranges from 4877 meters to 8848 meters above sea level which includes the world's highest peak - Sagarmatha (Mount Everest). This area comprises one-third of the total land area of the country of which a major portion always remain covered with snow.

2.2 Climate

The Himalayas in the north show a predominant influence on the climate of Nepal. Altitude divide the country into three broad climatic zones viz; sub-tropical in the Terai, temperate in the hills and alpine in the mountains. The rainfall is brought mainly by the south-east monsoon coming from Bay of Bengal which usually starts by mid-June and last till mid of September. The average annual rainfall of between 1500 to 2500 m.m predominates over

most of the country, with around 80 per cent of it confined to the June to September period. Eastern part of the country receives the highest rainfall which gradually decreases towards the West. The precipitation also decreases from South to North. During winter, the north-west wind bring nominal rain (Appendix - H). Temperatures during summer range from more than 40°c in the Terai to about 20°c in the Mid-Hills (Appendix I). Average maximum and minimum temperatures in the Terai during the winter are 23°c and 7°c respectively, while the valleys in the hills experience 12°c maximum and below freezing minimum (DOIHM, 1977).

2.3 Land Use

Nepal has very wide geographical diversity ranging from about 50m to 8848 meter above sea level within a width of about 190 kms (north to south) comprising plains, valleys, river and river basins, hills, high hills and the mountains of the Himalaya with different types of climates and farming practices within the same district and the same region. The land utilization status shown in Eighth Five Year Plan (1992-1997) show a share of 26.5%, 42.4%, 11.8% and 19.1% in agriculture, forest, pasture and other sector respectively as shown in Appendix - A (NPC, 1992). In consideration of rainfall, temperature and altitude, country is roughly divided into five geographical regions; Terai, Bhabar, Hills, High-hills and the Himalayan region. About 27.5 percent of the country's total land falls above 3000 meters above sea level and has limited population density and agriculture production due to its cold climate. About 13.6 percent of land is estimated to have steepness of one or a lesser degree and 58.8 percent of land with 20 degree steepness. Owing to extreme steep surface, the fragile hills create problems related to landslide and erosion resulting in the decline of productivity of land. Also, rapid deforestation for agricultural land causing adverse impact on environment in the terai. Considering all these facts, concerted efforts need to be made to formulate a detailed land use plan for developing arable land, pasture, settlements, urban areas, parks and forest.

There is unanimity about land utilization that it would be more beneficial to give priority to the maximum utilization of agro-ecological potentials in the formulation of the plans in near future. Taking this into perspective, the Eighth Plan has formulated policies in consonance with the sustainable utilization of land available in the country.

2.4 Population

Only two decades ago, Nepal's population was about 10 million. The 1991 census report shows a total population of 18.5 million with nearly equal numbers of male and female and has been growing at a rate of 2.08 per annum. The population density stands to about 126 person per sq. kilometres. The distribution of the population has been found to be; 7.82 percent in the mountains, 45.56 percent in the hills and 46.62 percent in the terai. The latest population census show the proportion of population has relatively decreased from 1981 to 1991 in the mountains as well as the hills. The share of the terai in the total population has considerably increased due to high migration from north to south because of higher opportunities for employment, better health, communication and education facilities. This unplanned migration from north to south has resulted in indiscriminate encroachment in the forest areas of the terai. More than 90 percent of the total population is still in the rural areas with minimum basic facilities.

2.5 Education, Health and Nutrition

Realizing the important role of education for all round development of the country, efforts were made to promote educational development in the country since 1951. The present education system in the country has been guided by National Education Plan implemented in 1971. Reforms are being made to suite the need of the country. In the year 1991/92, the primary enrolment is estimated to have reached 2.926 million in 18,681 primary schools and 0.767 million students in 6,173 lower secondary and secondary schools (NPC 1992). Primary education has been made free. Literacy campaign has been intensified. It is aimed to attain literacy rate of 67 percent from present 39 percent by the end of this century. For higher education more universities are being added with various technical fields.

In the field of health, it is aimed to make health services accessible to all by 2000 A.D. Presently the crude death rate and Infant mortality is 102 per thousand, while maternal mortality stands to 850 per 0.1 million births. The average life expectancy has been estimated 54.02 in 1991/92 (NPC, 1992).

The nutritional status of the majority of Nepalese population is low. The main reasons for low nutrition are the scarcity of food, imbalanced distribution, poor communication because of difficult terrain, lack of health services, poverty and illiteracy. The national nutrition survey of 1971 estimates that 50 percent of children are living under various conditions of malnutrition.

2.6 Economy

The economy of Nepal is primarily based on production from its principal natural resource-cultivable land, which is severely limited because of topography. The productivity of land is in declining trend because of decrease of soil fertility, unscientific land use and environmental deterioration. The country is heavily dependent on agriculture, in which more than 90 percent economically active population are engaged in producing 60 percent of the GDP. In previous plan period, the percentage growth of Gross Domestic Product of Nepal, in both agriculture and nonagricultural sector stood lower to the population growth; several factors accounted for the slow growth of GDP, chief among which are the landlocked, hilly terrain character of the country and heavy dependence on agriculture which in itself has been subject to uncertain climatic conditions and vagaries of monsoon.

In the previous plan period, there existed a vast gulf between the targets and the achievements. The average long term growth rate in domestic product was merely 3 percent and this was responsible for the lack of growth in per capita income. In view of the disappointing state of the per capita income and the increase in poverty, it has become imperative to achieve higher economic growth rate to improve the standard of living of the common people.

It is anticipated that the Eighth Plan would increase GDP growth rate to 5.1 percent as shown in Appendix-B. The total gross investment outlay for the Eighth Plan period (1992-97) is estimated to be Rs. 170,332 million as shown in Appendix-C. Out of the total gross fixed investment of Eighth Plan (NRs. 170, 332 million) about 64 percent i.e. NRs. 109,193 million is aimed to be invested by the private sector while the remaining 55.9 percent i.e. NRs. 61,139 million is aimed to be invested by the government sector. Thus,

compared to the Seventh Plan, investment during the Eight Plan period is estimated to be increased by 10.6 percent per annum.

In the Eighth Five year Plan, the Agriculture sector (including Fisheries) received budgetary allocation of NRs. 10,947 million of which the share of the fisheries sub-sector is only about 2.5 % (NRs.273.6 million).

2.7 Agriculture

Nepal is an agricultural country and it dominates the economy of the country. The sector provides employment to more than 90 percent of the population in producing about 60 percent of the Gross Domestic Products (GDP). About 80 percent of the export commodities also come from the agriculture sector. The major crops are cereals such as; rice, maize and wheat and cash crops such as; jute, oilseeds, pulses, sugar cane, potatoes and tobacco.

Besides cereal grains, animal husbandry has great importance in rural life and it is considered as an integral part of Nepalese Agriculture System. The sub-sector accounts for about 25 percent of the agricultural GDP and 15 percent of the total GDP. The sub-sector not only provides the power for cultivation and manure but also provide nutritious milk, milk products and meat for human consumption and hide and wool for industries. The consumption of animal protein including fish has been estimated as 8.0 kg per caput.

The contribution of the Fisheries sub-sector in animal protein consumption as well as in Nepalese economy at present is low (below 1 percent of GDP). However, fish as a protein rich diet is acceptable to every segment of the population. Fish as food has no social taboos like other meat. The demand of fish is steadily increasing in the country and the demand is meet by domestic production as well as by importing certain quality products from neighbouring countries to support tourism.

The domestic production comes from traditional capture fishery in natural waters as well as steadily increasing fish culture practices in the ponds and the lakes. The present low level of fish consumption is primarily due to lack of supplies and in some instances difficulties in distribution.

3. WATER AND FISHERY RESOURCES

Being a landlocked country, production of fish is entirely dependent on the proper utilization of its inland water resources. Production of fish can be significantly increased through proper development and management of capture as well as culture fisheries.

3.1 Water Resources

Nepal endowed with many form of water resources scattered throughout the country and occupy approximately five percent of the total land. In the inland water resources, the river take the major share. It is estimated that the country has more than 6000 rivers, of these 960 rivers are longer than 10 Kms while the rest are below 10 Kms (Shrestha, 1983). The major river systems are Koshi in east, Gandaki in central and Karnali, Mahakali in Far-West. All the major rivers originate in the Himalaya. Many more medium or small sized rivers, rivulets and streams originate from Mahabharat and Siwalik ranges too.

A number of medium and small sized lakes are scattered throughout the country. In addition a number of man made water bodies in the form of reservoirs and irrigated paddy fields, marshy and swampy lands also exist in the country. Besides, numerous man made village tanks and ponds are also located in the terai. The existing water resources have been tabulated in Table-1.

Table 1 : Estimated Water Resources

Serial	Type of Water Resources	Estimated Area	
		ha	%
1	Rivers	395,000	53.03
2	Lakes	5,000	0.67
3	Reservoirs	1,500	0.20
4	Village Ponds	6,262	0.84
5	Irrigated Paddy Field	325,000	43.63
6	Marshy land	12,000	1.61
		744,762	99.98

* Source-Fisheries Development Division, Harihar Bhawan, Lalitpur.

The future hydropower and irrigation projects have envisaged to bring a number of medium and large sized reservoirs in the country. It is estimated that such projected reservoirs are to increase the present water bodies to 152,200 ha (Pradhan, 1987). Similarly, more ponds are expected to be built under the Aquaculture Development Programme. The existing water resources as well as its future potential show a good scope to maximize the fish production by the expansion and intensification of the aquaculture practices.

3.2 Fishery Resources

Nepal has 184 fish species of which 174 species are indigenous and the rest 10 are exotic. The indigenous fish species are distributed in various river systems and water bodies of all climatic zones ranging from an altitude of 50m to 4000m above sea level. The warm waters of southern plain (Terai) has a number of high food valued fish species. The cold waters of mid-hills and mountainous regions have a number of species of sport fish as well as valued food fishes. The presence of diversified fish fauna in the country further widens the scope of commercial fishery. Out of the exotic, one fish species is of decorative value-the gold fish (Carassius carassius) which was introduced long ago and are being used in garden ponds and aquariums. Four fish species of higher food value, common carp (Cyprinus carpio), grass carp (Ctenopharyngodon idella), silver carp (Hypophthalmicthys molitrix) and bighead carp (Aristichthys nobilis), were introduced to develop commercial fish culture. Other four exotic fish of food value - red tilapia, Carassius auratus, Puntius gonionotus and rainbow trout (Salmo gairdenii) have been recently introduced.

4. FISHERY DEVELOPMENT PROGRAMME

4.1 Eighth Five Year Plan Target

Recognizing the importance of the fishery resources of the country, His Majesty's Government has given high priority in the Eighth Five Year Development Plan for the development of the fisheries sector with a view to generating additional income, creating employment opportunities and making available cheap animal protein for the poor rural population.

In the base year 1990/91, the total fish production was estimated at 12,656 mt; while in Eighth Five Year Plan period (1991-96), it has been targeted to raise the total production of fish to 22,311 mt, increasing the production level by an average annual growth rate of 10 percent. The details of fish target production for the Eighth Plan period has been shown in Appendix -D.

4.2 Ongoing Activities

In Nepal, production of fish mainly comes from traditional capture fisheries in natural waters and from culture practices in the ponds and lakes. The achievements made in fish production in previous years (1984-93), have been shown in Appendix -E.

4.2.1 Capture Fisheries

In Nepal, the capture fisheries is widely scattered throughout the country and is not well organized. Generally, the fishermen are scattered along the water bodies, the rivers and lakes, and use their traditional gears for their livelihood with nominal economic benefits. To date, no reliable statistics is available on the number of fishermen and their families involved in fishing for livelihoods. An early survey estimated that more than 20,000 people involved in capture fishery in Nepal (Swar, 1980). However, a recent study has estimated that more than 13,000 families (5-6 heads per family) are involved directly in fishing for their livelihood in addition to 9,000 part-time families (FDD, 1991).

The rivers, lakes, irrigated paddy fields and swamps are considered the main sources of fish production. Realizing the potentiality of the natural water resources, the government has accorded a high priority for its exploitation for fish production and one of the Fisheries Research Centre under NARC at Trishuli has been recently assigned to carry out the necessary studies. A significant increase in the fish production from these natural water resources could be anticipated in the near future through the introduction of better management and conservation practices. Total production from the capture fisheries is about 5000 mt.

4.2.2 Aquaculture

There are large numbers of ponds of various sizes in and around the villages of Terai and in the valleys of mid hills. Traditionally, these ponds were built to serve various socio-economic functions such as for domestic use, livestock, irrigation, culture of aquatic plants (water chestnut, lotus etc.) and traditional fish culture.

Traditional fish culture is practised to produce fish for family consumption. In traditional fish culture flood water is allowed to enter the village pond for two purposes; firstly, to

fill in the pond and secondly, to allow the wild fish seed to enter the pond and then these mixed seed are allowed to grow without any input and management. Fish production from such traditional practices is nominal.

In Nepal, the modern fish culture has a short history, as it was initiated in mid-forties only. In its early stages of development a considerable period was spent in selection of suitable indigenous as well as exotic fish species. With the selection of suitable fish species for local conditions, initial steps were undertaken in establishing two medium sized Fisheries Development Centres (FDC'S) in early sixties at Godawari (mid- hill) and Parawanipur (terai) in public sector where the culture practice along with propagation techniques were tested and adopted. The success in breeding of common carp (Cyprinus carpio) lead monoculture practices with considerable success in private sector. Later, the introduction of indigenous fingerlings of Catla (Catla catla), Rohu (Labeo rohita) and Mrigal/Naini (Cirrhinus mrigala) collected from rivers into the ponds along with common carp fingerlings led to polyculture practice with success. This led to the establishment of more Fisheries Development Centres at Tarahara, Janakpur, Pokhara and Bhairahawa. These FDCs then started to produce fish seed through artificial breeding techniques for distribution to the interested farmers.

Selection of additional three cultivable species of Chinese Carps - grass carp (Ctenopharyngodon idella), silver carp (Hypophthalmicthys molitrix) and bighead carp (Aristichthys nobilis) - helped in switching over to true polyculture system. The polyculture practice has considerably increased fish production per unit of water area and has provided higher economic benefits to the farmers, and this has attracted a large number of farmers into this activity.

This success has led to the establishment of more Fisheries Development Centres at Trishuli, Fatehpur, and Dhangadi with internal resources; two Commercial Fisheries Development Centres at Hetauda and Bhandara with the assistance of World Food Programme (WFP), and one Central Fish Hatchery at Balaju under Freedom From Hunger Campaign (FFHC).

Currently, there are eight Fisheries Development Centres in the country engaged in fish seed production and their distribution and four Fisheries Research Centres to carry out production oriented research activities. During the implementation of Fisheries Development Programme, special efforts are also being made to integrate fish culture activity with animal husbandry specially duck and pig rearing and with horticulture specially with banana and vegetable cultivation. The integrated fish culture with animal husbandry and horticulture has significantly increased fish production along with meat, fruits and vegetables in the districts. This has attracted a large number of farmers to take up fish culture activity as part time or full time job. With increased production, fish culture has succeeded in generating employment and income and improving nutritional status of the rural people. As a result, a development project (Aquaculture Development Project - Phase I) was implemented (1980-86) with the financial assistance from the Asian Development Bank and technical assistance from the United Nations Development Programme (UNDP). The project aimed at exploiting the existing ponds and constructing new ponds for fish culture. The project activities were implemented in 16 districts of Terai and inner-Terai. The project also strengthened existing public sector fish farms with additional infrastructures to cater for the ever expanding production area and also improving the professionals quality by rendering necessary training. The project covered a total of 3280 ha. of water bodies and produced 4162 tons of fish as shown in

Appendix E. Within the project period, the annual growth of fish production was about 10 percent. With increased fish production in the country, the importation of fish was limited to cater the big hotels only. In 1982/83, a survey of fish markets showed an export of 500 mt of fish to neighbouring countries (DFAMS, 1983). Fish export reached 1000 mt in 1985/86 with the increase of fish production (DFAMS, 1985).

The demonstrated economic viability of fish culture and the increasing interest of people to this activity made it possible to launch Aquaculture Development Project (ADP), Phase II, in 1987 as a follow up project of ADP, Phase-I, with financial support from the Asian Development Bank (ADB) and the International Fund for Agriculture Development (IFAD) and technical assistance from the UNDP. The Project supported the development of pond fish culture practices in 21 districts of Terai and inner-Terai of Eastern, Central, Western, Mid-Western and Far-Western Development Regions. It has also strengthened the seven public sector FDC's. The project helped to develop 2000 ha of water bodies (1200 ha of new ponds and 800 ha of old ponds) in private sector by providing 8000 (6000 for new pond and 2000 for old ponds) loans. The project also supported 15 Fish Breeders and 10 Nursing Centres in private sector to increase the fish seed production and helped improve the marketing system in the country.

Fish culture in conjunction with paddy cultivation was initiated in mid 1960's with considerable success. In recent years, problems have arisen because of the use of high amount of pesticides and insecticides in paddy fields. In spite of this, paddy cum fish culture has shown good potential for expansion in several parts of the country.

Integrating fish farming with livestock (especially with pigs and duck) and with horticulture (especially with vegetables and banana) has been demonstrated as very profitable. This practice has been accepted by a large number of farmers and is rapidly increasing. The integrated fish culture with cattle and buffalo for milk and bio-gas is sure to make fish culture activity more popular amongst the farmers in different parts of the country.

Cage fish culture with Chinese and Indian Major Carps in the lakes of Pokhara valley was started in the early 1970's under the assistance of UNDP/FAO. With the success of the trials, a revolving fund was established at Agriculture Development Bank, Pokhara with the assistance of FFHC. Since then, the fishermen have undertaken cage fish culture in the lakes of Pokhara Valley for which the Fisheries Development Centre and Agriculture Development Bank of Pokhara rendered the technical and financial assistance to the fishermen respectively. 214 fishermen families are involved in cage culture (384 floating cages) producing 60 tons of fish per annum (Rajbanshi & Gurung, 1991).

The technique of cage fish culture developed at Pokhara lakes has been further tested in newly commissioned man-made reservoir - Indra Sarovar at Kulekhani with very encouraging results. Some of the farmers have also adopted the cage fish culture practice in the reservoir with good production.

Fish culture in enclosure has also been initiated in the lakes of Pokhara especially in Begnas and Rupa lakes. These lakes have many coves with shallow waters and gentle slopes and have been found to be very productive. To explore the potential, an area of about 10 ha. has been brought under culture experiments (Rajbanshi and Gurung, 1991).

Valuable experience has been gained during the implementation of the various culture methods. Further refinement of these culture methods would be required to increase fish production in the country.

4.2.3. Culture Technologies

Pond fish culture

In Nepal, Pond fish culture includes all the three culture systems; extensive, semi-intensive and intensive. The ponds used for fish culture are the long existing village ponds. These village ponds were constructed primarily for water supply during the dry seasons for domestic needs and irrigation purposes and secondarily for traditional fish culture. Most of these ponds have no perennial water source and are seasonal in nature receiving run-off water during the rainy season. They were constructed very deep and it is not possible to drain them by gravity. The size of such ponds differ widely ranging from small ponds of 0.1 ha to several hectares.

Initially, improved fish culture practices were introduced in the existing village ponds in the Terai Region. In these ponds, stocked fingerlings are cultured without any significant addition of feed and fertilizer. The high return on investments achieved by this simple culture method has caused a rapid increase in the number of fish farmers who now look at fish culture as a cash crop for good investment.

With the starting of the Aquaculture Development Programmes, a large number of new ponds have been constructed mostly with perennial water source and other water control measures to improve pond environment. The improved water supply and pond management have resulted in higher survival rates and yielding higher production per unit area.

To prepare for culture, the fish pond is drained and left exposed to sun for at least a few weeks. The pond is treated with lime at the rate of 500-1000 kg/ha. When the fingerlings of cultivable fish species are available, the pond is filled with fresh water. To avoid entry of unwanted wild fish and predators, the water is screened at inlet. Organic fertilizer in the form of composted manure is broadcast at the rate of 3000-5000 kg/ha as initial dose to start the growth of natural food for fingerlings. With the development of natural food in the form of phytoplankton and zooplankton, the bigger sized fingerlings of cultivable fish species are stocked at the rate of 8000-10,000 fingerlings/ha. Additional organic fertilizer at the rate of 1000-1500 kg/ha are used in the pond each month on top of the initial dose of organic fertilizer. In addition to organic fertilizer, chemical fertilizer of different commercial brand are also used. Aquatic as well as soft terrestrial grass are provided in sufficient quantities to the voracious grass carp. The faeces of grass carp further fertilize the pond water. With the exception of progressive farmers who are adopting semi-intensive and intensive practices, the use of supplementary feed is not very common.

Growth check-up of the stocked fish is carried out at the interval of 2-3 weeks and the quantity of grass as well as supplementary feed is increased with the increase of fish body weight. On detection of pathogen or/and parasite, appropriate measures are taken immediately. Intensification of production practices are carried out either by adopting polyculture and/or by integrating livestock (duck and pig) and horticulture (fruit plants and vegetables) or both in a fish pond. The land surrounding the fish pond and its wide dikes are being properly used for constructing duck houses and/or pigstalls and banana

plantations. The integration of livestock and horticulture with fish reduces the cost of feed in fish culture. Thus the integration practice has become a means for increasing production and profits. The common carp, the chinese carps (silver, bighead and grass carp) and catla (Indian Major Carp) grow to harvesting size within 8-9 months of culture, while rohu and naini (mrigal) need two years of culture. Fish production under traditional and semi-intensive culture methods vary from 0.5 mt - 1.0 mt/ha/yr and 1.0 mt - 3.0 mt/ha/yr respectively, while the progressive farmers are producing over 3 mt/ha/yr with considerable inputs of feed and fertilizer. In 1992, about 10,000 mt of fish was reproduced by fish culture in ponds (Appendix - E).

Cage fish culture

The limnological studies of the three major lakes - Rupa, Begnas and Phewa of Pokhara valley - showed the presence rich phytoplankton and zooplankton throughout the year, which led to the development of cage fish culture in these lakes. Initially, this activity was started in collaboration with the Japanese Overseas Cooperation Volunteer (JOCV) group and later it was developed by the private sector with the support of UNDP and FFHC programme. The species cultured are the chinese carps (silver and bighead) and rohu (Indian Major Carp) for the local markets. Recently, this culture practice is being copied in other waterbodies.

The cage fish culture has been developed as an extensive culture practice for the poor fishermen living along the shore of the lakes who normally depend on the daily catch of fish for their livelihood.

The nylon cages are of various sizes ranging from 100 m^3 (5m x 5m x 4m) to over 250 m^3 (7.5m x 7.5 m x 4.5 m) of 15 mm to 30 mm mesh size. The upper surface of the cage is made up of local bamboo which help it to float. It is aimed to utilize the available natural food chain of phytoplankton and zooplankton of the water and no supplementary feed is used. Therefore, the planktonivorous fish species - silver carp (Hypophthalmichthys) and bighead carp (Aristichthys nobilis) are the main fish species used. During the culture period, the cage surfaces under the water usually get chocked with algae or freshwater sponge which may restrict circulation of water and cause deficiency of oxygen. To avoid this, a small number of fingerlings of Rohu are stocked. In each cage, fingerlings of silver, bighead and rohu of 25 gr - 45 gr each in the ratio of 49:49:2 respectively, and at the rate of 10 fingerlings/^{m3}, are stcoked.

In each month, growth check-up of the stocked fingerlings is carried out. The stocked fish are cultured for a maximum period of 8-10 months. Partial harvesting is a common practice. With the partial harvest of marketable fish, the cage is restocked with additional fingerlings. Average production from such cage fish culture is 4.7kg/m^3/yr. However, the fishermen who adopt multiple harvesting practice get higher yield per unit area. Total fish production from cage fish culture is about 120 mt per year.

Paddy-fish culture

Paddyfields capable of holding 30-40 cm depth of water are used for paddy-fish culture. Some of the farmer prefer to make certain modifications of the paddyfields by constructing ditches or slumps to provide adequate depth of water to culture fish and also to facilitate harvesting. Inlets and outlets are screened by means of wire screen or bamboo slits to stop the entry of wild fishes and other predators. The plantation of paddy is carried out

as usual. As the paddy plants grow with firm roots, the water level is gradually increased. After two or three weeks of planting paddy, the water level is maintained at 30-40 cm depth and then fingerlings of common carps are stocked. Usually, 2500-5000 fingerlings are stocked per hectare. This way fish are grown concurrently with paddy and this practice helps to eliminate weeds and insects. Fish yield depends on fish species, stocking rate, length of growing period, soil and water fertility and the extent of use of supplementary feed. Yields of 250-500 kg/ha/ is common and yields of up to 1000 kg/ha have also been reported by a number of farmers. The integration of fish culture with paddy cultivation provides fish for family consumption and additional cash income to the farmers. At present, only about 10 mt of fish is produced from paddy - fish culture.

5. FISHERIES INSTITUTIONS

Under the Ministry of Agriculture (MOA), the Department of Agriculture Development (DOAD) is primarily responsible for development, management and administration of the fisheries while fisheries research activities are carried out by NARC as shown in the Organizational Chart of Agriculture Sector in Appendix - F. Besides, the Department of Zoology under the General Science Faculty and Institute of Agriculture and Animal Science of Tribhuvan University are the institutions to provide academic courses on fish and fisheries.

5.1 Institutions for Development and Management

Out of many technical divisions under the DOAD, the Fisheries Development Division is the one that is responsible for over all development of Fisheries in the country. Under the framework of His Majesty's Government's policy and strategies, the FDD develops Fisheries Development's Programme and implements in the districts of different Development Regions through Fisheries Development Centres and District Extension Services. Under the FDD, there are eight Fisheries Development Centres at different regions and are responsible for implementing Fisheries Development Programme in collaboration with the respective district extension service at the district level. Presently, the Fisheries Development Programme covers 48 districts of five Development Regions. In previous development plan period, the sub-sector Fisheries has made considerable contribution to increasing income of farmers by increased fish production. In the base year 1990/91, the fish production has been estimated to 12,656 m. tons.

The Eighth Five Year Plan calls for maximum participation of private sector to increase fish production from 12,656 tons to 22,311 tons with an average annual growth rate of 10 percent. As the fish seed distribution is one of the main inputs required for increasing production, the plan aims to increase the present level of fingerling supply of 48.651 million in the first year to 59.857 million in the final year. In this venture, strong participation of the private sector farmers have been anticipated so that by the end of the plan period the present level of private sector contribution in fingerling production and distribution could be increased to 83 percent from present level of 76 percent (NPC,1992).

5.2 Institutions for Research and Education

In the course of organizational reform of agriculture research under the new Agriculture Policy and Strategies, an autonomous institution in the form of Nepal Agriculture Research Council (NARC) has been established in 1990/91 under the Nepal Agriculture

Research Council Act, 1991 to cater the agriculture research activities. Within NARC, National Animal Science Research Institute (NASRI) is responsible for animal husbandry and fisheries development and is headed by a Coordinator. Under the NASRI, the Fisheries Research Division is responsible for developing appropriate policies and strategies for fisheries research and action plans in support of production programme. For the implementation of action plan as well as to disseminate the technology, four Fisheries Research Centres located at different climatic zones have been established. The centrally located Fisheries Research Centre at Janakpur is responsible for carrying out research activities related to warm water pond fish culture; the centre at Pokhara is responsible for lake fisheries including cage culture; the Centre at Godawari is responsible for cold water fisheries; and the fourth centre at Trishuli is for capture fisheries.

The main objectives of aquaculture research have been the development and adaptation of culture technologies. The research programme has been categorized into two: (i) on station research and (ii) outreach research based in farmer's ponds/cages. The research programmes of both categories are designed to resolve the farmer's problems, identified through the extension officers.

Besides, the Department of Zoology and the Institute of Agriculture and Animal Science under the Tribhuvan University are the responsible institutions for academic courses in fisheries including aquaculture. Along with the academic courses, these institutions are also involved in carrying out basic and applied research under research schemes supported by national or international agencies. The graduates of these academic institutions are absorbed by the Fisheries Development and Research Programmes. However, there is very little cooperation between the academic, development and research institutions.

5.3 Institutions for Practical Training

Because of its success, aquaculture is rapidly growing in the country. A good number of farmers have taken up aquaculture as an economic activity and are now demanding improved or new technologies for higher production. Recognizing its growing popularity and future potential HMG has included aquaculture industry in its Basic Needs Programme.

To meet the above challenge, the Fisheries Development Programme has included training programmes for the professionals, technicians, extension agents and farmers. For this purpose, Fisheries Training Centre at Janakpur has adequate laboratory and field facilities. Other Fisheries Development Centres also have moderate facilities. Usually, the following five types of training courses are offered by the Fisheries Development Centres.

(a) Course for International Fellows

These training courses of Aquaculture Management and Extension are designed and executed at the request of international and bilateral agencies or organizations. The course includes theory as well as field works covering various aspects of aquaculture including hatchery management, production and extension. Recently, a training course on cage fish culture was conducted for a group of international fellows.

(b) Course for Professionals

These Courses are designed to orient the newly recruited professional officers with M.S or B.SC. Agriculture background for public fish farms and extension services. The

orientation course is designed for a period of 3 months and it covers all aspects of aquaculture and extension activities suited to local conditions. In the second year, the professionals are again called for a period of two weeks for in-service training courses on specific problems/issues.

(c) Course for Medium Level Technicians

These Courses are specifically designed to orient the newly recruited medium level technicians who are responsible for providing technical assistance to the farmers. The training course lasts for three man-months. After this training, the medium level technicians are deployed in the field as extension personnel.

(d) Course for Farmers

These Courses are designed to motivate as well as to orient the farmers to take up fish culture activity. The course covers all the major aspects of fish culture in very simplified version. Seven days training course to the farmers is carried out under the principle- "Learning by doing". After a lapse of certain period, the farmers are again called for refresher course to upgrade their know-how.

(e) Specific Course on Aquaculture for Special Group of Farmers.

Fifteen days training courses are specially designed to further upgrade the know-how of experienced fish farmer for specific activities eg; fish breeding, nursing, rearing etc. With this type of training the farmers get specialized in fish breeding, nursing and/or rearing activity along with fish production.

As a result of such courses, a good number of private sector farmers have become Fish Breeders and their contribution in fingerlings production and distribution has increased to as high as 80.7 percent of total fingerling production and distribution in the country (ADP-1993). The fish seed production and distribution activity has become more profitable than the production of food fish.

6. EXTENSION SERVICES

In the development of agriculture, the functions of extension services have been primarily aimed at disseminating the available information on technical, financial and input supplies to the farmers to help them to improve their farm ouput. The Agriculture Extension Service was established several decades ago along with Agriculture Development Programme. In the Agriculture Development Plan, food production (cereal grains) has always been given the highest priority to meet the growing demand for food for the ever increasing population. Accordingly, the General Agriculture Extension Service has been designed. However, it has also been made responsible for providing extension services to commodity sub-sectors, including fisheries. The institutional set-up of Agriculture Extension Service from central, regional to field level has been shown in Organizational Chart of Agriculture Sector in Appendix-F

6.1 Policies and Strategies

To meet the increasing demand for food, His Majesty's Government has placed agriculture development on top most priority and has envisaged higher growth rate in the Eighth Five year Plan (1992-1997). In previous development plan periods various extension methodologies were applied and tested for the dissemination of technologies and information. However, no methodology was found sufficiently effective for the purpose of designing a comprehensive extension system. On the basis of these experiences, HMG has adopted the following main strategies with the hope to develop a sound and effective extension system in the country during the current development plan period:

(a) Establish Agriculture Service Centres in the districts to function as technology extension centre

(b) Select and train farmers group (each group having 20/25 farmers) and develop them as contact group for the introduction of technology in the rural areas. For strengthening the technology adoption process, farmers should be kept under constant monitoring by the agriculture extension officer - the medium level technicians (J.T./J.T.A.).

(c) The extension services of different agriculture agencies will be brought under a single administrative unit to launch extension programme in an integrated way.

(d) The extension programme will be implemented on the basis of commodity sub-programmes.

(e) To ensure reliable supply of inputs and services, the Agriculture Service Centres will be further strengthened and made more efficient

(f) Demonstration of activities will be carried out in a reliable and convincing way

(g) Increased use of audio-visual materials will be made

(h) Special priority will be given to the task of organizing women's group in the course of implementing programmes related to production activities

(i) Credit facilities will be made easily accessible through the investment programmes of Agriculture Development Bank (ADB/N) and other financial institutions for increasing the production and generating further employment opportunities in the rural sector.

6.2 Institutional Framework

Under the Ministry of Agriculture, the Department of Agriculture Development is headed by a Director General and supported by seven Directors at the centre and five Regional Agriculture Directors at the five Development Regions (East, Central, West, Mid-west and Far-Western Development Region). The seven Directors are supporting hand to Director General and are assigned to supervise the technical divisions responsible for implementing and supervising the production as well as service programme. Out of the seven Directors at the Centre, one Director is assigned to look after the Fisheries Development Division. The five Regional Directors are stationed at the Region's headquarters under the direct

control of the Director General of DOAD, with the responsibilities for executing the agriculture production and extension programmes in the districts of the respective Region. Under the direct command of Regional Agriculture Directorate, a District Agriculture Development Office (DADO) has been established in each district (75 districts in the country) and this office is headed by the Agriculture Development Officer (ADO) who is an extension service agent of DOAD. The ADO is supported by a number of subject matter specialists as Extension Officer at district level depending on the intensity of agriculture development programme in the district. Recently, a broad principle has been developed to establish 7 Service Centres in a District of Terai, 5 for a Mid-Hill District and 3 for a Hill District to service agriculture development programme. Each Service Centre will be staffed by a number of medium level technicians-Junior Technicians (J.T.) and Junior Technical Assistants (J.T.A.) - to provide extension services to farmers' groups; while at grass root level i.e. at village level, the Progressive Farmers are made responsible for rendering services to neighbouring farmers.

Along with many other commodity extension programmes, Fisheries Extension also falls under the Regional Directorate of DOAD, and subsequently under the District Agriculture Development Office responsible for agriculture extension in a district. Depending on the size and intensity of the fisheries programme, Fisheries Extension Officers are made available to the DADO; while J.T.As. and farmers' groups are assigned to the Agriculture Service Centres and to the respective villages. Within the framework of Fisheries Development Programme of DOAD, the ADO is responsible for carrying out the planned activities.

6.3 Extension and Manpower Development

Out of the 75 districts, the Fisheries Development Programme covers 48 districts of which 21 districts fall under the Aquaculture Development Project. Within the project area, presently a cadre of 21 Fisheries Extension Officers as subject matter specialists, 146 medium level technicians (J.T. and J.T.A.) and 273 Progressive Farmers are being involved in Fisheries Extension Service at district headquarters, Agriculture Service Centre and in the villages, respectively.

Outside the project area, the fisheries extension activities are being carried out by the staff of the general agriculture extension service. The grass root level extension personnel are broadly classified as medium level Technicians and are graded into two categories : the lower level as Junior Technical Assistant and the higher level as Junior Technician. While the officer level personnel are graded into three different classes. A newly appointed officer initially starts from class three. In due course (usually after five years of service), they become legible candidate for the promotion to the next higher grade on the basis of their academic background, length of service, evaluation of their work, and availability of posts.

A secondary school education is required to be eligible for medium level technician post; while only a college graduate in Agricultural Science or its equivalent is eligible for officer level post. The newly recruited extension personnel (medium level technician or officer level) take an orientation course on aquaculture before their posting. Later, after some field experience, the extension personnel are also called for refresher courses or specific technical course to upgrade their technical know-how. The extension personnel also get opportunity to get nominated for higher technical training or academic courses or study tours, even in overseas institutions, depending on their technical performance in the field.

After recruitment, the Fishery Extension Officers having an agriculture degree or post graduation in Zoology with Fish and Fisheries specialisation receive 12 weeks orientation course on the principles and management of fish culture. Similarly, the medium level technicians (J.T. and J.T.A.) also gets 12 weeks practical training on fish culture. The Fisheries Assistants also get one week training course on practical aspects of fish culture. On successful completion of such orientation courses, the extension staff are deployed at their respective duty stations for the implementation of development programmes. To update the know-how of the extension agents, short term refresher training courses are also conducted, as and when required. Field training courses are also conducted for special groups of experienced farmers who intends to become commercial fish seed producers.

The Fishery Extension Officers (Subject Matter Specialists) are stationed at District Headquarters and are provided with motorbikes while the medium level technicians are assigned to rural areas and are provided with bicycles to cover their assigned area. The extension staff are also provided with nominal field kits and extension materials.

6.4 Public Institutions and Private Sector in Aquaculture Extension

The following institutions are directly or indirectly involved in aquaculture extension services.

6.4.1 Public Institutions

Fisheries Development Division (FDD)

Fisheries Development Division is a national level institution under DOAD and is responsible for planning and executing the Fisheries Development Programme. This institution is headed by the Chief Fisheries Development Officer, who is responsible to the Director General of DOAD and reports to the Director General through the Director of Fisheries. On the basis of feed backs obtained from various institutions such as Fisheries Development Centres, Fisheries Extension Services, researchers of NARC and the private sector fish farmers, the FDD develops the Fisheries Development Programme within the framework of the Five Year Plan. Each year, the prepared programme is discussed in Regional Planning Seminars for interaction amongst the development workers, researchers, extension services, bankers and representatives of the farmers. The programme is finalized with the consensus of the different institutions involved and is submitted for HMG approval. On getting approval, the development programme is implemented in the field by the DOAD and Regional Agriculture Directorate. The FDD supervises and monitors the implementation of the programme in the field and also provides technical feed back to the concerned higher authorities in the form of monthly and quarterly reports.

Fisheries Development Centres (FDC'S)

Presently, there are 12 Fisheries Centres out of which 8 are Fisheries Development Centres and they are under the administrative and technical control of FDD. The remaining 4 are Fisheries Research Centres and are under NARC. These centres are responsible for producing seed of cultivable fish species for their distribution to the farmers. Each FDC has a command area of 3-5 districts depending on its location. At the planning stage, the Fisheries Development Centres closely interact with the respective extension service and the farmers in identifying the potential areas for aquaculture development and their needs for inputs and training.

Agriculture Development Bank of Nepal (ADB/N)

The Agriculture Development Bank is responsible for supplying credit for development of agriculture including fish culture. The bank has district offices at the district headquarters and branch offices within the district to provide credit services to the interested farmers. At the planning stage, the bank fixes the loan target of a district; and at a later stage, it is further refined in close consultation with FDC as well as Extension Service of the district. The bank officials make detailed investigations of each loan proposal in close collaboration with the Extension Service as well as FDC's professionals. In some of the potential districts, the bank has recruited their own fisheries professionals for appraising the loan proposals.

Fisheries Research Centres under NARC

NARC has recently established Inland Fisheries Research Division under the NASRI and has made this Division responsible for carrying fisheries research activities. The Division controls four Fisheries Research Centres located at Terai and Mid - Hills of which the Fisheries Research Centre at Janakpur is responsible for carrying out research on warm water aquaculture, the Centre at Pokhara for Lake Fisheries, the Centre at Godawari for Cold Water Fisheries and the Centre at Trishuli for studying river fisheries. The active participations of these research units with the activities of the extension services units ensure successful dissemination of appropriate technologies to the fish farmers.

Agriculture Inputs Corporation (AIC)

The Agriculture Inputs Corporation is responsible for the supply of chemical fertilizers. This institution has offices in each district throughout the Terai and Mid-Hill regions from where the required fertilizers for pond fish culture could be procured. Presently, the demand of chemical fertilizer for pond fish culture is low as the farmers are more inclined to use compost manure. However, with the development of semi-intensive and intensive methods of farming systems, the demand for chemical fertilizer is increasing.

6.4.2. Non-Governmental Organizations (NGOs)

Two international Non-Governmental Organizations (NGOs) such as Peace Corps Volunteer (PCV) of USA and Japanese Overseas Cooporation Volunteer (JOCV) are involved in fisheries extension in Nepal. The former NGO has been involved since sixties in the development of pond fish culture, specially in Terai. The PCVs are science graduates and are trained locally to suit the local conditions of Terai. The trained volunteers are posted in the districts as Extension Agents for a period of two years and they are responsible for rendering technical services to the farmers. The services of the PCV's have greatly helped in bringing village ponds under fish culture with considerable success.

Similarly, a limited number of Japanese Volunteers specially trained to suit the local conditions have also participated in fish culture activities in Mid-Hills of Nepal, specially at Pokhara and Trishuli, with good success. This success has resulted in a large scale project (on-going) for the development of lake fishery at Pokhara and Trishuli.

A number of fish farmers with good field experience have become Fish Breeders to produce and distribute fish seed. To some farmers, this activity has become more profitable than the culture of marketable fish. To-date, 35 such Fish Breeders are

producing over 80 percent of the total fish seed production in the country. The Fish Breeders sell their fingerlings through the FDC and the government's extension services. A few Fish Breeders have their own extension agents for selling hatchlings and fingerlings to the fish farmers.

6.5 Methods and Systems of Extension

To motivate the farmers to take up fish culture activity and to accelerate fish culture development, all methods and systems of extension eg; individual, group, demonstrations, training and visits, field trips or excursions, group discussions, audio visual are practised.

As a first step in the process of aquaculture development, a technical study is made to assess the potential of a district or area for fish culture. A number of demonstration plots are identified to demonstrate the culture methods and results. Such activities are always supported with pamphlets, posters, audio visual aids and training programmes. The farmers are also encouraged to form groups eg. small farmers group, 4H Club for youth etc. Efforts have also been made to involve the whole community of a village in fish culture, where everybody in a village is involved in fish production. With the increase of fish production, its consumption among of the villagers have also increased considerably.

Similarly, the formation of Fishermen Association in each lake of Pokhara has given a feeling of ownership amongst the group members and as a result the Fishermen Association has taken certain measures to protect the lake environment for the benefit of fish culture in cages.

The medium level technicians (J.T and J.T.A) and the Progressive Farmers are the front-line of the Extension Services. The technicians are government employee and they train small groups of Progressive Farmers in all aspects of extension services. The Progressive Farmers are selected from the successful farmers. The village level fish culture extension services are therefore mainly carried out by the Progressive Farmers by demonstrating fish culture practices to the prospective/practising fish farmers. The Progressive Fish Farmers, in return for their services, receive free technical support from the Government. they also receive NRs.150 per month towards their travelling expenses for attending the monthly meeting at the District Agriculture Development Office.

6.6 Transfer of Culture Technologies

In Nepal, the modern fish culture techniques were initiated only in the early fifties with the support of US AID and later with assistance from UNDP/FAO. In those days, the facilities for fish culture development was very limited. Only in the sixties, efforts were made to establish a few small and medium sized Fish Seed Production and Culture Demonstration Centres in the country.

Dissemination of artificial propagation of fish

In the seventies, serious efforts were made to develop the technique of artificial propagation of fish for supplying quality fish seed to the farmers. These technologies were refined and simplified and were transferred to a number of progressive fish farmers through training and demonstrations. Nowadays, the private fish seed producers produce more fish seed than the public hatcheries (appendix G). The private sector farmers have found this activity as very lucrative. The increased fish seed production has ensured supply of fish

seed for a longer period and it has helped in intensifying fish culture activities for higher production. Dissemination of this technique to private sector has further helped in exploring the potential of fish culture even in remote or geographically disadvantaged areas where the supply of fish seed was a problem.

Fish culture practices

The extension services has also successfully transferred the standardized fish culture practices such as polyculture and fish culture integrated with agriculture, animal husbandry (specially duck and pig) and horticulture (specially banana and vegetables) amongst the farmers of the Terai and cage fish culture amongst the fishermen living along the three lakes of the Pokhara valley.

The polyculture practice is common amongst the farmers with a couple of years of experience in fish culture. Some of the farmers are very selective with certain species of fish because of their high market value. Similarly, in some of the areas, the integrated fish culture has been found to be very successful. Presently, about 1638.3 ha of water bodies are under integrated fish culture system of which 253.6 ha with pig and 1384.7 ha with fruits and vegetables (ADP, 1993). Number of farmers involved in fish culture increased from 4800 in 1983 to 13,400 in 1990 (Appendix J).

In cage culture, about 200 families are operating 384 cages in the three lakes of Pokhara and producing about 120 tons of fish. This activity was supported by FAO-FFHC under a revolving fund. Recently, this technology has been successfully adopted by the private sector in Indra Sarovar Reservoir (a hydropower reservoir) at KuleKhani.

6.7 Input Supply and Subsidies

The various inputs needed by farmers are fish seed, fertilizer, feed and feed ingredients, and credit for which various institutions have been established and are made responsible for their supply.

Fish seed

Fisheries Development Centers, the Fish Breeders and Nursery Farmers are responsible for producing and supplying fish seed to the interested farmers in their command areas. Appendix- G shows the details of public and private sectors' fry and fingerling production and distribution during the last six years (1987/88 to 1992/93). In these years, the private sector has exhibited a distinct supremacy over public sector in production and distribution of fish seed. In 1993, the private sector produced about 80 % of the total fish seed production in the country. It is anticipated that in the near future the private sector's contribution to fish seed production would increase.

Fisheries Development Centers as well as the farmers fix the price of fish seed according to their size and the time of the year. The average prices of fry/fingerlings from public and private sectors are shown in Table 2.

Table 2 : Price of Fish Seed
(Public and Private Sector)

Fish Seed	Unit	Rate (Rupees) Public sector	Rate (Rupees) Private sector
Hatchling - Common Carp - Chinese Carps and Indian Major Carps	 100,000 100,000	 150 250	 150 250
Fry (2-3 cm)	10,000	1500	1500-2500*
Fingerling (7.5-10 cm)	10,000	5000	10,000

* depending on the month of supply

Fertilizer

Agriculture Inputs Corporation (AIC) is responsible for the supply of chemical fertilizer in Nepal. This institution has branches and sub-offices in most districts. The application of chemical fertilizer in fish culture activity is still low because of its high price. In the rural areas, the farmers mostly use organic manure as most of the farmers have their own cattle. The fish farmers use manure either in fresh or in compost form.

Feed and feed ingredients

There are a number of animal feed factories, but not a single factory manufactures commercial fish feed. The commercial feed for animals are mainly produced for poultry, pig and cattle. The price of such commercial feed range Rupees 6 - 10 / kg of feed depending on its protein value.

Recently, some groups of fish farmers have realized the importance of supplementary feed for achieving higher production and they have started preparing fish feed with locally available feed ingredients eg. rice, wheat and maize bran, mustard and soyabean oil cake, fish meal, and domestic wastes. Two Fisheries Development Centers in the public sector are now working on the development of fish feed at low cost with local ingredients.

Credit

The Agriculture Development Bank of Nepal (ADB/N) is responsible for supplying credit facilities to the farmers. The ADB/N has district and sub-offices in most of the districts. In the period of Aquaculture Development Project Phase I (1981/82 - 1985/86) a total of 2848 farmers received NRs.386.33 million credit for 1226.35 ha of fish pond (ADB/N, 1986); while for the period of Aquaculture Development Project, Phase II (1987/88 - 1992/93), a total of 1817 farmers received credit facilities of NRS. 62.699 million. The loan is given at the interest rate of 18 percent per annum. Very recently, the government has lowered the interest rate to 16 percent per annum.

A loan proposal is initially prepared by an extension agent on the request of the farmer. The loan proposal is then examined and refined by ADB/N staff. If required, the ADB/N seeks technical assistance from the professional of the respective FDC. To avoid the misuse of loan as well as high interest burden to farmers, the disbursement of an approved loan is made in instalments. For smooth execution of a loan project the extension service as well as the technical staff of FDC extend the necessary technical support to the loanee free of cost. Besides, the extension personnel are also asked to keep their eye open on the utilization of the loan in the field and they feed back information to the Bank and the FDC. In cases where new ponds are to be constructed, the first year is considered as incubation period when interest is not charged. For small farmers group, lower interest rate is charged, as this group of farmers are covered under Small Farmers Development Programme executed directly by ADB/N.

6.8 Programme Implementation and Monitoring

The general agriculture extension system is responsible for rendering extension services to all fields of agriculture including fisheries. However, in seventies, extension staff were not trained in other commodities of agriculture besides the major crops. In other fields of agriculture including fisheries the extension staff failed to make any visible impact. As a result, the sub-sector Fisheries, was left behind along with animal husbandry and horticulture, from the main stream of Agriculture for a considerable period.

At a later stage, due emphasis was given for the development of sub-sector Fisheries. Efforts were made to introduce Peace Corps Volunteers (PCV) as fisheries extension agent under technical cooperation programme Peace Corps, of the government of the U.S.A. The deployment of specially trained volunteers as extension agents in the villages gave very encouraging results in the Terai. The Peace Corps Volunteers were posted at the potential pockets of the terai districts in close consultation with DADO and respective FDC. The posting was made under the administrative control of DADO and technical supervision of the FDC of the area. The was the turning point in the development of fish culture and led to the following three activities;

(a) survey of water bodies in the districts of Terai to evaluate the potential of fish culture;
(b) designing of special field training courses on fish culture suitable to local conditions; and
(c) establishing specially trained national extension cadre for the promotion of fish culture

Specially trained extension staff were posted in areas of aquaculture potential in the Terai region, with the responsibility for each extension officer to develop pond aquaculture in 20-25 ha of water area. This was followed by the implementation of the Aquaculture Development Project, Phase-I, funded by the Asian Development Bank. The Project activities covered 16 districts under 7 FDC's. The project headquarters was established at Janakpur, Central Development Region, for the effective coordination and field supervision of the project area.

In implementation of the project activities, mainly three institutions viz. the FDCs, District Agriculture Development Office and Agriculture Development Bank of Nepal were involved at district level. To create good understanding and good working atmosphere in between the institutions and personnel involved, a detail implementation procedure was developed

jointly spelling out all the details of activities, duties and responsibilities of each institution and workers with time frame under the principle of "Three in one Action". Thus, Fisheries Extension Service was established to work with the farmers under the administrative control of DADO but technically and financially dependent on the FDC.

The working principle "Three in one Action" not only helped the institutions to understand each other but it also helped in developing a working relationship amongst the workers of different institutions. As a result, each activity was implemented effectively with increased credit flow and increased fish production. The fisheries extension activities were carried out by general agriculture extension service. Field activities were supervised from the Central Government by the Regional Directorate of respective region, Fisheries Development Division and Department of Agriculture.

The success of ADP Phase I was immediately followed by ADP Phase II (1987/88 - 1993/94). The project achieved a considerable success in strengthening the public sector FDC's and training of professionals.

The progress made in the field was reported in monthly reports. Each Fisheries Development Centre collected progress report from its command area, compiled the results and submitted to the Fisheries Development Division. The progress reports of Fisheries Development Centres were technically analysed and compiled and was submitted to the Department of Agriculture Development. On quarterly basis, the progress made against plan target was reviewed at Ministerial level and on half-yearly basis at Planning Commission level.

The related technical data collected at district and grass-root level were compiled and verified at Fisheries Development Division and Department of Agriculture for further use in development planning and research and the relevant information were relayed to the concerned agencies.

The extension services of a command area had direct linkage with Fisheries Development Centre for technical matters; and for administrative and financial matters, it communicated through the District Agriculture Development Office and Regional Directorate. However, urgent matters were discussed and resolved in the District Coordination Committee.

7. PRODUCTION AND MARKETING

7.1 Production

The estimated fish production of last seven years has been shown in Appendix - E, while the production of first year of Eighth Plan has been estimated at 16,809 tons of which 7340 tons to come from capture and 9469 tons from culture. The baseline survey of 1986/87 has shown an average yield of 1.58 tons per hectare per year. The Appraisal Report of Aquaculture Development Project (Phase II) estimated that through gradual intensification yield can be improved substantially up to 3.0 tons/ha/yr or even higher.

7.2. Marketing

Fish from pond culture are usually harvested in the winter season and are packed in bamboo baskets, lined with jute sack and sal (Shorea robusta) green leaves, with ice to maintain the quality of the fish for a couple of days.

It is estimated that about 20 - 25 percent of the output from pond fish culture is used for local consumption and wage payment for labourers while 80 percent are sold in the markets. Out of the fish marketed major portion is consumed within the country and small portion of about 3 - 5 percent is exported to adjacent markets across the boarder.
In Nepal, the fresh fish marketing system is not well developed. In recent years, few private sector entrepreneurs have got interested in this field and have taken some preliminary measures to develop a marketing system specially in those areas where the fish production is increasing. The packed fresh fish are mostly transported by night buses to the densely populated towns across the boarder in India where freshfish are in high demand and fetch higher price. To facilitate preservation of fresh fish, a chain of chill rooms and ice making facilities have been installed at various centres viz. Bhairahawa, Hetauda, Pokhara and Kathmandu.

To-date, no proper statistical data are available to assess production by species as well as consumption trend in Nepal. However, out of the cultured fish production, it is estimated that silver, grass, bighead and common carps make the major share of about 60 percent and the rest by indigenous fishes like rohu, catla, mrigal and others.

8. ECONOMICS

The implementation of fish culture activities in the rural areas of Terai has successfully turned the village ponds into a source of food fish. They are also generating jobs and income. A study on the economics of pond fish culture has shown that pond fish culture generates four times higher income than any cereal crop, three times higher than high value livestock and vegetable, and two times higher income than high valued cash crops in farming system (Baral, 1992).

Fish seed production has been found to be more lucrative. Because of their higher return, a number of Progressive Farmers have taken up these activities. The farmers involved in these activities earn an estimated annual gross income of NRs. 50,000 - 150,000/ha depending on locations. Detailed information on cost of production and profits under various culture technologies are expected to come from the recently completed Data Validation and Socio-Economic Survey under Aquaculture Development Project, Phase II.

9. SOCIO - ECONOMIC BENEFITS

So far, no authentic data are available on socio - economic benefits of fish culture activity. The available estimates are from spot checks and opinions expressed by fish farmers.

9.1. Employment

It is said that the members of a farmer's family can take full share of labour needed for smooth operation of a small sized fish culture activity. While for medium sized operation

they take a share of about 25 - 50 percent of the activities and the rest of the activities are completed by employing labourers - unskilled and skilled, specially for repairing or maintaining ponds and harvesting fish. At present, the farmers estimate that about one labourer is needed to manage one hectare of fish pond and the need of labour increases with the integration of fish culture activity with other agricultural activities and with intensification of culture systems.

9.2. Nutritional Benefits

No base line information is available on fish consumption, however, the national per caput of fish consumption has been estimated to be below one kilogram. However, it is believed that the per capita fish intake amongst the fish farmers and the other people in the locality appear to be far higher than the national average as the fish pond operators use about 20 - 25 percent of their production for family consumption and for wages for labourers.

10. CONSTRAINTS

The extension service plays a vital role not only in promoting production programme but also in generating opportunities for jobs and additional income develop effective general agriculture extension service system. In spite of repeated efforts, no methodology was found sufficiently effective for a comprehensive agriculture extension system. Without any exception the fisheries extension under general agriculture extension system also failed to meet the expectation inspite of effort and investment made in earlier days.

In the process of developing an appropriate Fishery Extension Service, a lot of experience has been gained with the deployment of Peace Corps Volunteers, specially trained in fish culture. Encouraged by good results, actions were taken to expand and intensify the production programme to a larger area of the country and ultimately led to the implementation of large-scale Aquaculture Development Projects. Under the ADP, Phase I, the extension service have been successful in attaining the projected targets. Locating the project headquarters in the field had greatly facilitated the development of a good working relationship amongst the institutions and personnel involved in the implementation of the project.

Under the Aquaculture Development Project, Phase II, the production programme has been further intensified and expanded to the districts of Mid-Western and Far-Western Development Regions. The Fisheries Extension Service has been placed directly under the control of general Agriculture Extension Service, making periodical field supervision by the professionals difficult; firstly, because of poor communication in Mid-Western and Far-Western Development Regions under the project; and secondly, the shifting of the project headquarters from the field (Janakpur) to the capital (Kathmandu). The shifting of headquarters from field to capital has further dissipated the institutional strength the project attempted to build. This arrangement has confined the experienced senior professionals along with the project vehicles within the compass of the capital and not giving them much opportunity to get into the field to provide extension services.

The separation of administrative, financial and technical control also played a large part in making Fisheries Extension Service less effective. Lack of training and equipment, and complicated administrative system have also contributed to low morale and low confidence

amongst the fisheries extension staff, making them ineffective in dealing with the farmers'problems.

Moreover, the temporary nature of recruitment of Fisheries Extension staff for the duration of a project period only, has also contributed to a high rate of turn over, as staff sought permanent employment elsewhere.

Thus, the lack of a functional institutional framework and low morale of the staff are the main constraints to the development of an effective Fisheries Extension Service in Nepal.

11. CONCLUSIONS

The present arrangement of a comprehensive extension services system, of which fisheries extension service is a part, is obviously not the best arrangement for providing extension services to the fish farmers. In an unified service like this, the first priority of the extension workers is for crops and most or all of them are primarily trained as Agriculture Extension Officers. So far, the system has worked fairly well for fisheries mainly because of the fact that the services were provided under the umbrellas of well funded fisheries development projects. With the completion of the development projects and the subsequent absorption of the extension services functions into the regular government programme, the capacity and effectiveness of the extension services will come under scrutiny. However, considering the achievements in aquaculture to-date and the potential for further development, serious thoughts should be given to the establishment of a specialized aquaculture extension service unit under the general Agriculture Extension Services system.

Too many institutions with very complicated institutional arrangements are involved in the operation of the aquaculture extension services. To make the extension services effective, the complicated administrative, financial and technical controls should be simplified, and more authority should be delegated to the district and field officers.

The principle of "Three In One Action" established for the implementation of the ADP (phase I and II) have been effective. Under that system the three main institutions viz. Fisheries Development Centres, Agriculture Development Bank and District Agriculture Development Offices have been working for a common goal - providing aquaculture extension services to the fish farmers. This system of operation should be established in all the districts with potential for further development of aquaculture.

The Fisheries Research Centres at Janakpur (for pond culture) and Pokhara (for cage culture) need to be strengthened and directed more towards extension oriented outreach adaptive research in farmers' ponds/cages. The system of feed-back of information related to farmers' problems to the research centres should be formalized through regular reporting mechanism.

A reliable data base for each district is a pre-requisite for planning, implementing, monitoring and evaluation aquaculture development programmes/projects. The Extension Service should establish a database on aquaculture for each district.

The use of Progressive Farmers as Demonstration Farmers for the extension of fish culture has been found to be successful in the Aquaculture Development projects funded by the

Asian Development Bank. Under this system, the Progressive Farmers benefit from the direct technical support from the extension agents and the neighbouring farmers who are interested to embark on or improve upon their fish culture practices benefit from the practical demonstrations of improved fish culture technologies in the ponds of a Progressive Farmer. This system also ensures rapid expansion of aquaculture by bringing in a large number of farmers under the umbrella of the extension services within the shortest period of time. The government should adopt this system nationwide.

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Appendix A

Land use Patterns

Types	Land (in hectare)	Percentage
Agriculture	3,954,915	26.5
Cultivated	2,968,017	20.0
Uncultivated	986,898	6.5
Forest	6,306,460	42.4
Forest Land	56,18,052	37.8
Shrubs	6,88,408	4.6
Pastures	1,757,345	11.8
Others	2,836,322	19.2
Snow Capped Areas	5,06,317	3.4
Rocky Surface	1,966,092	13.2
Stone/Sand	3,22,428	2.3
Steep Terrain	5,575	0.0
Barren Land	13,414	0.1
Lake/Pond	11,584	0.1
Urban Area	10,914	0.1
Total	148,55,042	100

Appendix B

Sectoral and Total Growth Rate (Value Added)
(in millions of rupees at constant price of 1991/92)

	1991/1992		1996/1997		Annual Rate
	Amount	Share %	Amount	Share %	
1. Total (1.1 + 1.2)	113,024	100.0	142,993	100.0	4.8
1.1 Agriculture, Irrigation	62,712	55.5	75,364	52.7	3.7
1.2 Non-Agriculture Sector	50,312	44.5	67,629	47.3	6.1
Industry and Mining	7,283	6.4	12,119	8.5	10.8
Electricity, Gas and Water	1,054	0.9	1,617	1.1	8.9
Construction	9,408	8.3	11,604	8.1	4.3
Trade, Hotel and Restaurant	5,995	5.3	8,685	6.1	7.7
Transport and Communications	6,878	6.1	8,548	6.0	4.4
Finance and Real Estate	9,321	8.3	11,735	8.2	4.7
Social Services	10,372	9.2	13,270	9.3	5.0
2. Indirect Tax (net)	8,038		12,168	8.6	6.8
Gross Domestic Product (at market price)(1 + 2)	121,062		155,160		5.1

Appendix C

Investment Outlay for the Eighth Five Year Plan (1992-97)

(In million NRs)

SECTOR	Seventh Plan		Eighth Plan	
	Amount	Share %	Amount	Share %
Total Gross Fixed Investment	103,014	100.0	170,332	100.0
Agriculture, Irrigation and Forestry	25,270	24.5	43,876	25.8
Industry and Mining	7,572	7.4	14,925	8.8
Electricity, Gas and Water	17,246	16.7	27,668	16.2
Construction	3,382	3.3	5,072	3.0
Trade, Hotel and Restaurants	2,678	2.6	6,581	3.8
Transport and Communications	15,881	15.4	26,119	15.3
Finance and Real Estate	23,970	23.3	33,184	19.5
Social Services	7,015	6.8	12,907	7.6

Appendix D

Production targets of the Fishery Development Programme during the Eighth Five Year Plan (1992 - 1997)

(in metric tons)

S.N.	Particular	Base Year (1990/91)	1996/97
1	Pond Fish production Regular Programme Semi-Intensive Programme Intensive programme	7.162	12,552 2,273 6,063 4,216
2	Paddy Field Fish production	12	125
3	Lake Enclosure culture	24	45
4	Other Reservoirs	12	172
5	Lake Cage culture	54	150
6	Improved Fry in Lakes	35	100
7	By-products of Govt. Farms	76	134
8	Natural Water reservoirs	5281	9,033
		12,656	22,311

Appendix E

FISH PRODUCTION*
(1984-1993)

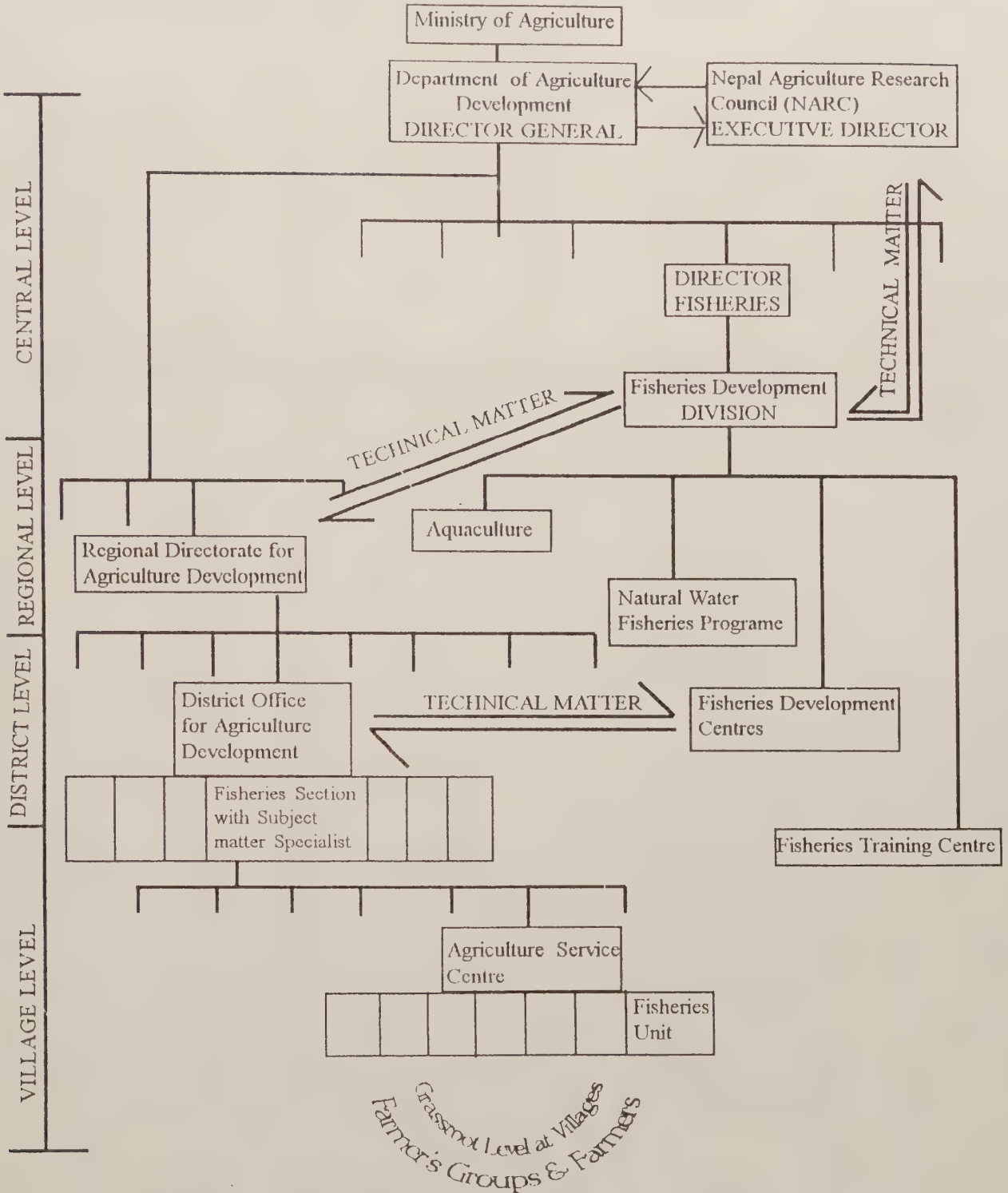
(metric tons)

YEAR	DIFFERENT CULTURE PRACTICES				CAPTURE	TOTAL
	Ponds	Cages	Paddy field	Sub-total		
1984	-	-	-	1997	2200	4197
1985	-	-	-	3265	2200	5465
1986	4112	50	-	4162	5281	9443
1987	5373	58	4	5435		
1988	5040	76	9	5125		
1989	6710	116	10	6836		
1990	9128	120	10	9258		
1991	10184	120	10	10314		
1992	-	-	-	10621		
1993	-	-	-	9434	7375	16809

*Source: Fisheries Development Division and FAO

Appendix-F

ORGANIZATIONAL CHART OF AGRICULTURE SECTOR
INCLUDING INLAND FISHERIES



Appendix G

FRY/FINGERLING PRODUCTION*
(1987/88 - 1992/93)

(in million)

Sources of Fry/Fingerling Production	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
A. Public sector						
1. Fisheries Development Centres	9.80	10.10	9.70	9.74	8.50	10.39
B. Private sector	9.20	13.00	15.80	26.51	35.60	39.02
1. Fish Breeder	6.70	9.30	11.70	22.31	21.60	19.75
2. Nursery Operator	2.50	3.70	4.10	4.20	7.10	9.27
3. Dealers					6.90	10.00
TOTAL	19.00	23.10	25.50	36.25	44.10	49.41
Private Sector Contribution in %	48.42	56.27	61.96	73.13	80.72	78.89

* Status Report of Second Aquaculture Development Project, Dec. 1993

ANNUAL RAINFALL*
(1981 - 1990)

(In mm)

PLACES	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Southern Terai										
Biratnagar	1868	1403	1597	2110	1739	1712	2571	1971	2665	2354
Janakpur	1201	581	1726	1829	1939	1282	2389	2059	1408	1364
Bhairahawa	2468	1673	1514	2240	1540	1849	1408	2130	2024	1834
Nepalgunj	2174	1657	1669	2012	1657	1009	1292	1909	1510	1564
Dhangadhi	-	-	2310	2374	1778	1444	1395	1658	1824	2303
Mid-Hill										
Dharan	2198	1827	2428	2851	2483	1778	3038	-	-	-
Hetauda	2363	2032	2185	2406	2740	2747	2481	2232	2176	2768
Kathmandu	1370	1168	1449	1313	1786	1495	1395	1441	1132	1536
Pokhara	3614	3355	3609	4175	3249	3907	3918	4032	4070	3620

Source: Fisheries Development Division

Appendix I

TEMPERATURE*
(1981 - 1990)

(in centigrade)

Places	1981		1982		1983		1984		1985		1986		1987		1988		1989		1990	
	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
Southern Teral																				
Biratnagar	37.0	6.3	40.8	6.0	37.0	4.2	38.7	4.2	39.0	6.0	39.3	6.0	34.2	9.8	35.3	9.2	35.9	7.7	32.5	9.8
Janakpur	37.8	7.6	42.0	5.0	39.0	4.0	40.0	2.5	40.0	5.0	39.4	5.5	35.9	10.7	34.2	9.7	36.6	8.4	34	10.4
Parananipur	39.5	4.5	41.5	5.5	40.0	3.0	40.0	4.5	41.5	3.5	40.7	7.0	-	-	-	-	-	-	-	-
Bhairahawa	42.0	6.6	42.0	6.7	42.4	3.5	42.0	4.2	42.0	6.5	41.7	6.4	37.6	9.9	35.9	8.4	37.3	8.3	35	9.5
Nepalgunj	42.0	6.0	41.5	7.0	43.0	5.5	42.4	3.0	43.0	6.0	42.0	6.2	39.5	10.2	37.9	8.8	38	8.1	35.7	9.2
Mill-Hill																				
Dharkuta	28.6	4.4	28.9	4.6	27.6	3.0	28.6	3.2	28.0	5.0	28.4	5.8	24.3	8.6	24.7	8.5	24.9	6.7	25.0	9.4
Kathmandu	31.2	-1.2	32.9	-1.0	33.7	-2.0	32.0	-2.6	31.7	-1.2	32.0	-0.2	29.1	2.4	28.9	3.0	30.0	1.8	29.2	3.2
Rampur	38.0	3.0	41.6	5.0	41.4	1.8	41.0	3.6	42.2	4.8	41.8	3.4	-	-	-	-	-	-	-	-
Pokhara	32.6	2.6	35.0	3.0	34.4	1.0	33.8	1.8	35.4	3.5	33.0	10.0	30.8	6.9	30.3	8.2	31.2	6.9	31.2	7.6
Surkhet	38.0	2.2	37.0	3.5	38.4	2.2	38.2	1.8	39.8	2.5	39.3	2.8	-	-	-	-	-	-	-	-

*Source: Climatological Records of Nepal. Department of Hydrology and Meteorology

Appendix J

NUMBER OF FARMERS INVOLVED IN FISH CULTURE* (1983 - 1990)

YEAR	NUMBER OF FISH FARMERS	
	Annual increase	Total
1983	4,800	4,800
1984	+2,200	7,000
1985	+1,100	8,100
1986	+2,400	10,500
1987	+400	10,900
1988	+900	11,800
1989	+800	12,600
1990	+800	13,400

*Source: Fisheries Development Division

D/V9485E/1/11.95/2225